

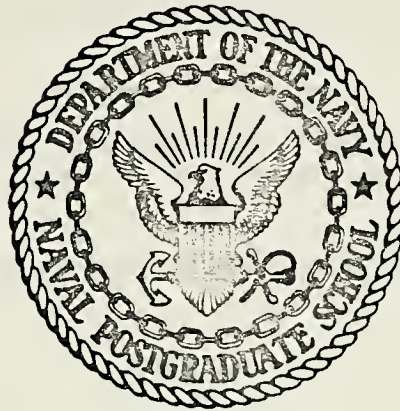
A SYSTEMATIC APPROACH TOWARD DEVELOPING  
ASW TACTICS BASED ON PLAUSIBLE SOVIET RESOURCE  
ALLOCATION

Robert Louis Peck

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# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

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ASW TACTICS BASED ON PLAUSIBLE SOVIET RESOURCE  
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by

Robert Louis Peck

Thesis Advisor:

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March 1974

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A Systematic Approach Toward Developing ASW Tactics  
Based on Plausible Soviet Resource Allocation

by

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## ABSTRACT

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This thesis relates the fact that, in the past, our ASW community has placed great (and justifiable) emphasis in detection and classification of submarines, while a serious lag in tactical procedures has developed. In order to alleviate this problem, it was felt that a systematic approach be taken which utilizes the principles of Operations Research.

By examining submarine warfare from the viewpoint of the Soviet Union, a resource allocation problem has been devised which compares the various submarine classes and the possible mission areas in which they may be assigned. Characteristics and available numbers of submarines were estimated, and the resulting allocation of forces was determined.

Although the analysis presented was based on hypothesized data, the strength in this approach lies in its flexibility and a wide range of applications. These features have been presented in Section III.





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## I. INTRODUCTION AND BACKGROUND

The threat of submarine attack has been, from the period of the United States Civil War to the present, one of the most perplexing problems in warfare. A continuing struggle has been waged to produce new and more sophisticated detection devices and weaponry to combat this threat. Yet, with the advent of each anti-submarine measure has come increasingly sophisticated submarines and their associated striking powers. Tactics, too, have followed this continual see-saw in an effort by each side to gain some slight advantage over the other.

Today, the anti-submarine warfare community finds itself in a position of having to contend with a large variety of modern nuclear and conventional submarines, each with special operating characteristics and tasked with distinct operational objectives.

It has been noted that, "our usual attitude is along lines of long, reliable detection ranges with excellent classification characteristics."<sup>1</sup> In essence, we have placed great (and justifiable) emphasis in detection and classification, while a serious lag in tactical procedures has developed. In view of the variety of undersea weapons platforms our potential adversaries are continually producing, we must take positive and carefully formulated corrective measures to alleviate this situation.

This paper utilizes the principles of Operations Analysis to direct our anti-submarine tactical methodology toward the specific threats we are most likely to face in our various naval operations. By accepting the premise that the Soviet Union has developed a systematic allocation

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<sup>1</sup> Anti-Submarine Warfare Laboratory Report No. NADC-AW-N5906, Future Detection and Classification Methods in Anti-Submarine Warfare (U), p. 1, 5 March 1959 (SECRET document).





of its submarine resources, we will be able to anticipate both the strength, and nature of the forces we may oppose in a wartime environment.



## II. ANALYSIS

### A. DEVELOPMENT

It is the goal of this paper to provide a systematic approach toward examining Soviet submarine resources, the various mission areas in which these resources may be utilized, and ultimately, the allocation of these assets. With full realization of the rapidly expanding Soviet naval posture and the recent advances of their technology, it is reasonable to assume that they currently employ Operations Research/Systems Analysis principles in much the same manner as do Western scientists. In this regard, Admiral of the Fleet of the Soviet Union S.G. Gorshkov stated, "We have had to cease comparing the number of warships of one or another type and their total displacement (or the number of guns in a salvo, or the weight of this salvo), and turn to a more complex, but also more correct appraisal of the striking and defensive power of ships, based on a mathematical analysis of their capabilities and quantitative characteristics."<sup>2</sup>

Putting ourselves behind the desk of the top military decision makers in the Kremlin we will view the submarine warfare picture through "red colored glasses" and develop an optimal solution to the problem of submarine allocation. By adopting this method of analysis we will determine a rational approach we might expect the Soviet analysts to take in submarine mission assignments, and will therefore facilitate optimizing U.S. ASW tactics to counter our most likely opponents.

Visualize, if you will, Admiral Gorshkov calling to his office, the leaders of the Soviet Navy. He has before him, two charts; one showing

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<sup>2</sup> Gorshkov, S. G., "Navies in War and in Peace," United States Naval Institute Proceedings, Vol. 100, Number 1, p. 19-20, January 1974.



the sixteen submarine types currently serving the fleet, and the other showing the ten missions on which these submarines are likely to be employed. Figure 1 lists the submarines and missions under consideration. To the leaders assembled before him, Admiral Gorshkov assigns the task of determining an "optimal" allocation of the submarine fleet. The scenario he prescribes is one in which the U.S. has refused to heed numerous grave warnings issued by the Soviet Union. As a result of repeated U.S. threats to the freedom of the Soviet people, all-out war is close at hand.

Upon leaving Admiral Gorshkov's office, the leaders decide to present this problem to their military analysts.

After several weeks, the Naval Analysis Branch presents to the leaders, a report containing several alternatives from which Admiral Gorshkov and his staff select the linear program discussed below.

## B. LINEAR PROGRAM

Table I displays a resource-mission matrix<sup>3</sup> in which the pertinent submarine capabilities and limitations have been examined in order to determine which of the mission areas each type of submarine would be likely to be assigned. This table shows that four of the original six mission areas have been subdivided. The anti-convoy mission has been expanded to include missions whose sole objective is to sink merchant vessels, and missions tasked with

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<sup>3</sup> It is important to note that to preclude the necessity of security classification, submarine characteristics and total numbers available have been approximated, and are presented for purposes of illustration. These numbers are consistent with those currently available in unclassified sources.



destroying specific cargos (petroleum, steel, armament, etc.). The anti-United States Task Group mission area has been subdivided into missions aimed at placing aircraft carriers out of commission, and missions designed to destroy carrier defenses. The missions designed to strike continental U.S. targets have been divided into those to strike industrial areas and those to strike SAC bases. Barrier patrols have been redefined to be patrols to counter the submarine threat, and barriers to counter the surface ship threat.

The characteristics for each submarine type listed in Table I were used to determine possible missions for each submarine class. Ranges have been divided into short (S), medium (M), and long (L). Speeds are listed as slow (S) for those whose maximum submerged speed is less than, or equal to sixteen knots, and fast (F), for those capable of submerged speeds in excess of sixteen knots. The category of power was divided into conventional (C), and nuclear (N). Weapons loads for the various submarines are torpedoes (T), guided missiles (G), and ballistic missiles (B). Notice that, in all cases, those classes of submarines which are armed with missiles also carry torpedoes. In addition, because it is unreasonable to expect that all submarines are available at any given time, the number of each submarine type available has been chosen to be eighty percent of the totals.

In Table I, an X represents the decision that a submarine of type i would be a reasonable choice to fulfill mission j. For example, a Z class sub might be assigned to counter merchant shipping, but due to the submarine's characteristics, would be a poor choice in a role against U.S. Task Groups.

The decision was made to formulate a linear program which maximized the utility of the submarine fleet, subject to the constraints that all





mission areas were to be fulfilled, and that the number of submarines of each type was not to be exceeded.

In order to meet this objective, each class of submarine was compared with a reference class (in this case, the Y class was chosen). The subjective determination was then made as to the "value" of a submarine of type i. Based on the age of each class and its overall contribution toward insuring the security of the U.S.S.R., these values were assigned to the classes as shown in Table II. For example, one Y class submarine is "worth" nine E class subs. Another way of viewing these values is to answer the question; "The loss of how many E class submarines is equal to the loss of one Y class sub?" Due to the nature of the objective function, and in order to facilitate computations, a base value of one was chosen for the Y class submarines.

Next, the marginal utility of each submarine in its possible mission areas was determined. By examining the requirements of each mission, and by knowing how much a given submarine contributes toward the mission, these quantities were calculated. Marginal utility values are shown in Table II. For example, each H class submarine represents three percent of the total requirement needed against U.S. SAC bases. Stated in different terms, using only H class submarines to counter U.S. SAC bases, 33.3 subs would be needed.

In mathematical notation, the linear program is as follows:

$$\begin{array}{ll}
 \text{Maximize} & z = \sum_{j=1}^{10} \sum_{i=1}^{15} V_{ij} X_{ij} \\
 \text{Subject to} & \sum_{j=1}^{10} X_{ij} \leq b_i \quad \forall \quad i \\
 & \sum_{i=1}^{15} a_{ij} X_{ij} = 1 \quad \forall \quad j
 \end{array}$$



$$x_{ij} \geq 0 \quad \forall i, j$$

where  $V_{ij}$  = the value of a submarine of type  $i$  on mission  $j$ <sup>4</sup>,

$X_{ij}$  = the total number of submarines of type  $i$  used on mission  $j$ ,

$b_i$  = the total number of type  $i$  submarines available,

$a_{ij}$  = the marginal utility of type  $i$

Note that the expression  $\sum_{i=1}^{15} a_{ij} X_{ij} = 1 \quad \forall j$  is the constraint that all missions be fulfilled<sup>5</sup>.

With the objective function and the constraint equations listed above, and the marginal utilities and values shown in Table II, a computer program was written to determine an optimal allocation of the available submarines. Table III illustrates the values determined.

It was seen that in several instances two or three classes of submarines were similar in that they were capable of performing the same missions, and had been assigned similar values and marginal utilities.

To simplify the linear program, a revised matrix utilizing combined marginal utilities, and averaged values was determined. This matrix is shown in Table IV. Table V displays the corresponding solutions to the linear program. It is readily seen that combining classes of submarines

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<sup>4</sup> While each submarine type has been assigned a value, it must be noted that  $V_{ij}$  is zero in many cases. For example, the value of a Z class sub against merchant shipping is 20, while its value against CVA's is zero.

<sup>5</sup> In the context of this analysis "fulfilled" means that the missions are to be accomplished to some input degree. For example, to fulfill the convoy mission does not necessarily mean that all convoy ships are sunk. The actual value of the target amounts would then constitute different Soviet Strategies.



affected the solution very little.

The computer analysis used in the preparation of this paper was conducted using the Mathematical Programming System (MPS-360) package in conjunction with an IBM-360 computer. It is felt that MPS-360 is an excellent tool in such analyses, and has special merits, in that the capability to perform sensitivity analyses is incorporated into the system. A listing of the computer program and output follows Section III. Also, see Ref. 4 for detailed instructions concerning the use of MPS-360.



### III. DISCUSSION AND CONCLUSIONS

It is recognized that in formulating the linear program described in Section II from the viewpoint of the Soviet Union, a rather "simplistic" approach was taken. Obviously, by utilizing detailed intelligence information as inputs, outputs more closely approximating the real world could have been obtained. In addition, by defining marginal utility to mean "missions per submarine," some economists might argue that it is unreasonable to expect that each submarine added to a particular mission area contributes the same amount toward fulfilling the goal of the mission as did the previous submarine (i.e., is it reasonable to assume that marginal utilities are constant?).

Often, we have been content to rely on World War II methods which were successful before the emergence of the nuclear submarine. From these outdated tactics we have devised tactics for implementation in today's Navy. Our current tactical publications consist of numerous procedures limited in scope, and general in nature. Is it not reasonable to expect that with the specialized nature of our current naval missions we may anticipate encountering adversaries equally specialized? Such a redundant question should certainly point towards devising new tactics designed to meet a modern challenge.

A closer examination of the methods presented in this paper reveals that through the use of the linear program we are able to conduct meaningful sensitivity analyses. By fixing one input we may examine the range of other variables for which a given solution remains unchanged. For example, we may ask the question, "Assuming that the characteristics of the other classes of Soviet submarines do not change, how will the adversaries we may expect to face vary as a particular class of





submarines is phased out of service, or new classes are introduced?"

In addition, we may use the outputs generated by this model to evaluate current tactics. For example, by analyzing a given tactic we may be able to predict the type of submarine characteristics most vulnerable to that tactic. Then by determining on which of our missions we would be most likely to encounter those submarines, we will be able to conduct more specific training to strengthen our capabilities. In recent years there have been encouraging results from experimental tactics evaluated during fleet exercises<sup>6</sup>. Certainly, the information resulting from this linear program can serve to amplify our belief that these new tactical methods have merit in given circumstances, and we will be able to evaluate alternative courses of action.

Perhaps even more importantly, use of these methods will enable us to evaluate the overall effects of a change in tactics in a given area. For example, a new CVA screening tactic cannot be expected to result in greater survivability of the CVA if the enemy elects to commit proportionally greater submarine assets to the anti-CVA mission. In this case, the value of the new screen tactic will be manifested in increased survivability of the target of some other submarine mission. The identity of this target, and the magnitude of the savings might be estimated from this program.

Application of the linear program presented here is not restricted to the all-out war scenario described, nor is it limited to the characteristics of the submarines listed. In a limited war in which one or more missions described in the analysis are not applicable, the linear program may easily be modified. Similarly, as new submarine classes are

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<sup>6</sup> See Ref. 2.



established or as new missions are foreseen, this approach may also be used.

Without question there are many avenues yet to be examined in regard to the implementation of such an approach to our ASW. In particular, devising new tactics suggested by the output of the linear program will require detailed development of the input variables. When assigning actual marginal utilities to submarine missions, the scope and nature of the missions must be very thoroughly analyzed. For example, by stating that 20 submarines of type i are required to fulfill mission j, we must be willing to estimate both the mission objectives and the submarine capabilities in considerable detail.

It has not been the intent of this paper to provide "the" answer to the difficulties facing our current ASW endeavors. Rather, the methods presented here are offered as one logical approach to ASW, designed to eliminate some of the guesswork and outmoded bases which now serve as foundation for much of our efforts.

Used as a tool, the linear program and extensions of the methods presented here will enable our policy makers to take a fresh look at the many and varied aspects of Anti-Submarine Warfare.



<u>SUBMARINE TYPES</u>	<u>MISSION AREAS</u>
B P	DEFEND HOMELAND
C Q	ANTI-MERCHANT SHIPPING
E R	ANTI-CONVOY
F V	ANTI-U.S. TASK GROUP
G W	BARRIER PATROL
H W (conv)	STRIKE CONTINENTAL U.S. TARGETS
J Y	
N Z	

SUBMARINE TYPES AND MISSION AREAS

Figure 1



RE-SOURCE	RANGE	SPEED	POWER	WEPS.	TOTAL	AVAIL.	MISSION									
							mer-ship	convoy		task-group		cont. U.S.		defend USSR	anti-barrrier	
								hulls	cargo	CVA	DD's	SAC	indus.		sub	surf.
Q	S	S	C	T	10	8		X	X							X
B	M	S	C	T	5	4		X						X		X
W	M	S	C	T	35	32		X						X		X
R	M	S	C	T	15	12		X						X		X
Z	L	S	C	T	10	8	X	X								
F	L	S	C	T	50	40	X	X								
W(conv)	M	S	C	G/T	5	4				X	X			X		X
J	L	S	C	G/T	15	12				X	X			X		X
G	L	S	C	B/T	20	16						X	X	X		X
N	L	F	N	T	15	12			X		X			X	X	X
V	L	F	N	T	15	12			X		X			X	X	X
E	L	F	N	G/T	25	20				X			X	X		
P/C	L	F	N	G/T	20	16							X			
H	L	F	N	B/T	10	8						X	X	X	X	X
Y	L	F	N	B/T	40	32						X	X			

RESOURCE-MISSION MATRIX

TABLE I





RE-SOURCE	U.S. ΔC	MISSION										
		mer-ship	convoy		task-group		cont. U.S.		defend U.S.S.R.	anti-barrier		
			hulls	cargo	CVA	DD's	SAC	indus.		sub	surf.	
Q	25		.03	.02								.03
B	24		.04						.03			.04
W	23		.05						.04			.05
R	23		.06						.05			.05
Z	20	.05	.08	.06								
F	20	.04	.06	.05								
W(conv)	17				.10	.10			.10			.11
J	17				.12	.10			.12			.13
G	17							.01	.04	.08		.07
N	15			.11		.09			.07	.05		.09
V	13			.10		.08			.07	.07		.09
E	9				.12				.03	.06		
P/C	7								.03			
H	5							.03	.06	.08	.08	.06
Y	1							.04	.07			

MARGINAL UTILITIES

TABLE II



RE-SOURCE	MISSION											AVAIL.	USED	SLACK
	mer-ship	convoy		task-group		cont. U.S.		defend USSR	anti-barrier					
		hulls	cargo	CVA	DD's	SAC	indus.		sub	surf.				
Q			8.00									8	8	-
B								4.00				4	4	-
W		10.64						13.56			7.80	32	32	-
R											12.00	12	12	-
Z			8.00									8	8	-
F	25.00	7.80	7.20									40	40	-
W(conv)				4.00								4	4	-
J				5.00	7.00							12	12	-
G						16.00						16	16	-
N										12.00		12	12	-
V					3.75					5.71		12	12	-
E							17.33	2.67				20	20	-
P/C							16.00					16	16	-
H						7.83					.17	8	8	-
Y						2.37						32	2.37	29.63

Z = 3842

OPTIMAL ALLOCATION

TABLE III



RE-SOURCE	W Z Y	MISSION									
		mer-ship	convoy		task-group		cont. U.S.		defend USSR	anti-barrier	
			hulls	cargo	CVA	DD's	SAC	indus.		sub	surf.
Q	25		.03	.02							.03
B,W,R	23		.05						.04		.05
Z,F	20	.04	.06	.05							
W(c), J	17				.12	.10			.12		.13
G	17						.01	.04	.08		.07
N,V	14			.10		.08			.07	.06	.09
E	9				.12			.03	.06		
P/C	7							.03			
H	5						.08	.06	.08	.08	.06
Y	1						.09	.07			

MARGINAL UTILITIES (MODIFIED)

TABLE IV



RE-SOURCE	MISSION											AVAIL.	USED	SLACK
	mer-ship	convoy		task-group		cont. U.S.		defend USSR	anti-barrier					
		hulls	cargo	CVA	DD's	SAC	indus.		sub	surf.				
Q			8.00								8	8	-	
B,W,R		12.56						15.44		20.00	48	48	-	
Z,F	25.00	6.20	16.80								48	48	-	
W(c),J				8.33	7.67						16	16	-	
G						16.00					16	16	-	
N,V					2.92			4.42	16.67		24	24	-	
E							18.78	1.22			20	20	-	
P/C							14.55				16	14.55	1.45	
H						8.00					8	8	-	
Y						2.22					32	2.22	29.78	

Z = 3468

OPTIMAL ALLOCATION (MODIFIED)

TABLE V





MPS-PTF4            EXECUTOR.        MPS/360 V2-M10

SOLUTION    (OPTIMAL)

TIME = 0.90 MINS.    ITERATION NUMBER = 43

...NAME...	...ACTIVITY...	DEFINED AS
FUNCTIONAL RESTRAINTS	3482.37222	VALUE ALOT1



SECTION 1 - ROWS

NUMBER	...ROW...	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT.	..UPPER LIMIT.	..DUAL ACTIVITY
1	VALUE	BS	3442.37222	3482.37222-	NONE	NONE	1.00000
2	SUR1	UL	8.00000	.	NONE	8.00000	24.64444-
3	SUR2	UL	4.00000	.	NONE	4.00000	23.44444-
4	SUR3	UL	32.00000	.	NONE	32.00000	22.25926-
5	SUR4	UL	12.00000	.	NONE	12.00000	22.25926-
6	SUR5	UL	8.00000	.	NONE	8.00000	18.93333-
7	SUR6	UL	40.00000	.	NONE	40.00000	19.11111-
8	SUR7	UL	4.00000	.	NONE	4.00000	15.64969-
9	SUR8	UL	12.00000	.	NONE	12.00000	15.37963-
10	SUR9	UL	16.00000	.	NONE	16.00000	16.88889-
11	SUR10	UL	12.00000	.	NONE	12.00000	14.07407-
12	SUR11	UL	12.00000	.	NONE	12.00000	11.70370-
13	SUR12	UL	20.00000	.	NONE	20.00000	7.88889-
14	SUR13	UL	16.00000	.	NONE	16.00000	5.88889-
15	SUR14	UL	8.00000	.	NONE	8.00000	4.11111-
16	SUR15	RS	2.37222	29.62778	NONE	32.00000	22.22222-
17	MIS1	EQ	1.00000	.	1.00000	1.00000	14.81481-
18	MIS2	EQ	1.00000	.	1.00000	1.00000	17.77778-
19	MIS3	EQ	1.00000	.	1.00000	1.00000	13.50309-
20	MIS4	EQ	1.00000	.	1.00000	1.00000	16.20370-
21	MIS5	EQ	1.00000	.	1.00000	1.00000	11.11111-
22	MIS6	EQ	1.00000	.	1.00000	1.00000	37.03704-
23	MIS7	EQ	1.00000	.	1.00000	1.00000	18.51852-
24	MIS8	EQ	1.00000	.	1.00000	1.00000	18.51852-
25	MIS9	EQ	1.00000	.	1.00000	1.00000	14.81481-
26	MIS10	EQ	1.00000	.	1.00000	1.00000	14.81481-



## SECTION 2 - COLUMNS

NUMBER	COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	..REDUCED COST.
27	X11	LL	.	25.00000	.	NONE	24.64444-
28	X12	LL	9.00000	25.00000	.	NONE	.08889-
29	X13	HS	.	.	.	NONE	24.64444-
30	X14	LL	.	.	.	NONE	24.64444-
31	X15	LL	.	.	.	NONE	24.64444-
32	X16	LL	.	.	.	NONE	24.64444-
33	X17	LL	.	.	.	NONE	24.64444-
34	X18	LL	.	.	.	NONE	24.64444-
35	X19	LL	.	.	.	NONE	24.64444-
36	X110	LL	.	25.00000	.	NONE	08889-
37	X21	LL	.	.	.	NONE	23.44444-
38	X22	LL	.	24.00000	.	NONE	.03704-
39	X23	LL	.	.	.	NONE	23.44444-
40	X24	LL	.	.	.	NONE	23.44444-
41	X25	LL	.	.	.	NONE	23.44444-
42	X26	LL	.	.	.	NONE	23.44444-
43	X27	LL	.	.	.	NONE	23.44444-
44	X28	HS	4.00000	24.00000	.	NONE	23.44444-
45	X29	LL	.	.	.	NONE	23.44444-
46	X210	LL	.	24.00000	.	NONE	.03704-
47	X31	LL	.	.	.	NONE	22.25926-
48	X32	RS	10.64000	23.00000	.	NONE	22.25926-
49	X33	LL	.	.	.	NONE	22.25926-
50	X34	LL	.	.	.	NONE	22.25926-
51	X35	LL	.	.	.	NONE	22.25926-
52	X36	LL	.	.	.	NONE	22.25926-
53	X37	LL	.	.	.	NONE	22.25926-
54	X38	RS	13.56250	23.00000	.	NONE	22.25926-
55	X39	LL	.	.	.	NONE	22.25926-
56	X310	HS	7.79750	23.00000	.	NONE	22.25926-
57	X41	LL	.	23.00000	.	NONE	22.25926-
58	X42	LL	.	.	.	NONE	22.25926-
59	X43	LL	.	.	.	NONE	14815-
60	X44	LL	.	.	.	NONE	22.25926-
61	X45	LL	.	.	.	NONE	22.25926-
62	X46	LL	.	.	.	NONE	22.25926-
63	X47	LL	.	.	.	NONE	22.25926-
64	X48	LL	.	.	.	NONE	22.25926-
65	X49	LL	.	23.00000	.	NONE	18519-
66	X410	LL	.	.	.	NONE	22.25926-
67	X51	RS	12.00000	23.00000	.	NONE	.04444-
68	X52	LL	.	20.00000	.	NONE	.11852-
69	X53	LL	.	20.00000	.	NONE	18.93333-
70	X54	RS	3.00000	20.00000	.	NONE	18.93333-
71	X55	LL	.	.	.	NONE	18.93333-
72	X56	LL	.	.	.	NONE	18.93333-
73	X57	LL	.	.	.	NONE	18.93333-
74	X58	LL	.	.	.	NONE	18.93333-
75	X59	LL	.	.	.	NONE	18.93333-



NUMBER	COLUMN.	AT	ACTIVITY...	INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	..REDUCED COST.
76	X510	LL				NONE	18.93333-
77	X61	RS	25.00000	20.00000		NONE	.
78	X62	RS	7.80000	20.00000		NONE	.
79	X63	RS	7.20000	20.00000		NONE	.
80	X64	LL				NONE	19.11111-
81	X65	LL				NONE	19.11111-
82	X66	LL				NONE	19.11111-
83	X67	LL				NONE	19.11111-
84	X68	LL				NONE	19.11111-
85	X69	LL				NONE	19.11111-
86	X610	LL				NONE	15.64969-
87	X71	LL				NONE	15.64969-
88	X72	LL				NONE	15.64969-
89	X73	LL				NONE	15.64969-
90	X74	RS	4.00000	17.00000		NONE	27006-
91	X75	LL		17.00000		NONE	15.64969-
92	X76	LL				NONE	15.64969-
93	X77	LL				NONE	50154-
94	X78	LL		17.00000		NONE	15.64969-
95	X79	LL				NONE	15.64969-
96	X710	LL		17.00000		NONE	27932-
97	X81	LL				NONE	15.37963-
98	X82	LL				NONE	15.37963-
99	X83	LL				NONE	15.37963-
100	X84	RS	5.00000	17.00000		NONE	.
101	X85	RS	7.00000	17.00000		NONE	15.37963-
102	X86	LL				NONE	15.37963-
103	X87	LL				NONE	60185-
104	X88	LL		17.00000		NONE	15.37963-
105	X89	LL		17.00000		NONE	30556-
106	X910	LL				NONE	16.88889-
107	X91	LL				NONE	16.88889-
108	X92	LL				NONE	16.88889-
109	X93	LL				NONE	16.88889-
110	X94	LL				NONE	16.88889-
111	X95	LL	16.00000	17.00000		NONE	16.88889-
112	X96	RS		17.00000		NONE	1.37037-
113	X97	LL		17.00000		NONE	1.37037-
114	X98	LL		17.00000		NONE	16.88889-
115	X99	LL				NONE	92593-
116	X910	LL		17.00000		NONE	14.07407-
117	X101	LL				NONE	14.07407-
118	X102	LL				NONE	14.07407-
119	X103	LL		15.00000		NONE	1.02963-
120	X104	LL				NONE	14.07407-
121	X105	LL		15.00000		NONE	53241-
122	X106	LL				NONE	14.07407-
123	X107	LL				NONE	14.07407-
124	X108	LL		15.00000		NONE	1.37037-
125	X109	RS	12.00000	15.00000		NONE	37037-
126	X1010	LL		15.00000		NONE	40741-





MPS-PTF4	EXECUTOR	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	..REDUCED COST.	PAGI
127	NUMRER	COLUMN.						
128		X111	.	.	.	NONE	11.70370-	
129		X112	.	13.00000	.	NONE	11.70370-	
130		X113	.	.	.	NONE	48148-	
131		X114	RS	13.00000	.	NONE	11.70370-	
132		X115	.	.	.	NONE	.	
133		X116	.	.	.	NONE	11.70370-	
134		X117	RS	2.53571	13.00000	NONE	11.70370-	
135		X118	RS	5.71429	13.00000	NONE	11.70370-	
136		X119	.	.	.	NONE	.	
137		X120	.	.	.	NONE	.03704-	
138		X121	.	.	.	NONE	7.88889-	
139		X122	.	.	.	NONE	7.88889-	
140		X123	.	.	.	NONE	7.88889-	
141		X124	.	9.00000	.	NONE	7.88889-	
142		X125	.	.	.	NONE	50926-	
143		X126	.	.	.	NONE	7.88889-	
144		X127	RS	17.33333	9.00000	NONE	.	
145		X128	RS	2.66667	9.00000	NONE	.	
146		X129	.	.	.	NONE	7.88889-	
147		X130	.	.	.	NONE	7.88889-	
148		X131	.	.	.	NONE	5.88889-	
149		X132	.	.	.	NONE	5.88889-	
150		X133	.	.	.	NONE	5.88889-	
151		X134	.	.	.	NONE	5.88889-	
152		X135	.	.	.	NONE	5.88889-	
153		X136	RS	16.00000	7.00000	NONE	5.88889-	
154		X137	.	.	.	NONE	5.88889-	
155		X138	.	.	.	NONE	5.88889-	
156		X139	.	.	.	NONE	5.88889-	
157		X140	.	.	.	NONE	4.11111-	
158		X141	.	.	.	NONE	4.11111-	
159		X142	.	.	.	NONE	4.11111-	
160		X143	.	.	.	NONE	4.11111-	
161		X144	.	.	.	NONE	4.11111-	
162		X145	RS	7.83125	5.00000	NONE	1.33333-	
163		X146	.	.	5.00000	NONE	59259-	
164		X147	.	.	5.00000	NONE	59259-	
165		X148	.	.	5.00000	NONE	.	
166		X149	RS	16875	5.00000	NONE	.	
167		X150	.	.	.	NONE	.	
168		X151	.	.	.	NONE	.	
169		X152	.	.	.	NONE	.	
170		X153	.	.	.	NONE	.	
171		X154	.	.	.	NONE	.	
172		X155	.	.	.	NONE	.	
173		X156	RS	2.37222	1.00000	NONE	1.59259-	
174		X157	.	.	1.00000	NONE	.	
175		X158	.	.	.	NONE	.	
176		X159	.	.	.	NONE	.	
		X160	.	.	.	NONE	.	

A A A A A A A



MPS-PTF4

## CONTROL PROGRAM COMPILER - MPS/360 V2-M10

```

0001      PROGRAM
0002      INITIALZ
0065      MOVE(XDATA,'SUBS')
0066      MOVE(XPRNAME,'PECK1')
0067      MOVE(XOBJ,'VALUE')
0068      MOVE(XRHS,'ALOT1')
0069      CONVERT('SUMMARY')
0070      BCDOUT
0071      SETUP('MAX')
0072      PRIMAL
0073      SOLUTION
0074      EXIT
0075      PEND

```

```

IEC130I SYSABS DD STATEMENT MISSING
IEC130I SYSPUNCH DD STATEMENT MISSING
IEF285I SYS1.MPS360LP PASSED
IEF285I VOL SER NOS= WAPY
IEF285I SYS74052.T115457.PV000.PECK1336.R0000001 DELETED
IEF285I VOL SER NOS= SPOOL3.
IEF285I SYS74052.T115457.RV000.PECK1336.R0000002 DELETED
IEF285I VOL SER NOS= SPOOL3.
IEF285I SYS74052.T115457.RV000.PECK1336.R0000003 DELETED
IEF285I VOL SER NOS= SPOOL1.
IEF285I SYS74052.T115457.RV000.PECK1336.R0000004 DELETED
IEF285I VOL SER NOS= SPOOL2.
IEF285I SYS74052.T115457.FV000.PECK1336.R0000005 PASSED
IEF285I VOL SER NOS= SPOOL3.
IEF285I SYS74052.T115457.SV000.PECK1336.R0000006 SYSOUT
IEF285I VOL SER NOS= SPOOL1.
IEF285I SYS74052.T115457.PV000.PECK1336.S0000007 SYSIN
IEF285I VOL SER NOS= SPOOL2.
IEF285I SYS74052.T115457.RV000.PECK1336.S0000007 DELETED
IEF285I VOL SER NOS= SPOOL2.
IEF373I STEP /MPS1 / START 74052.1155
IEF374I STEP /MPS1 / STOP 74052.1156 CPU 0MIN 01.58SEC MAIN 70K LCS OK
APPROXIMATELY- 14 SYSOUT LINES THIS STEP *** PLEASE BLOCK ***
XXMPS2 EXEC PGM=EXECUTOR,COND=(0,NE,MPS1),TIME=2,REGION=100K 00000090
XXSTPLIB DD DSN=SYS1.MPS360LP,DISP=SHR 00000100
XXSYMLCP DD DSN=SYS1.MPS1.SYMLCP,DISP=(OLD,DELETE) 00000110
XXSCRATCH1 DD UNIT=SYSDA,SPACE=(CYL,(3),,CONTIG) 00000120
XXSCRATCH2 DD UNIT=SYSDA,SPACE=(CYL,(3),,CONTIG) 00000130
XXPROBFILE DD UNIT=SYSDA,SPACE=(CYL,(3),,CONTIG) 00000140
XXMATRIX1 DD UNIT=SYSDA,SPACE=(CYL,(3),,CONTIG) 00000150
XXETA1 DD UNIT=SYSDA,SPACE=(CYL,(3),,CONTIG) 00000160
XXMPSCRAT DD UNIT=SYSDA,SPACE=(CYL,(3),,CONTIG) 00000170
XXSYSPRINT DD SYSOUT=A,DCB=(RECFM=UA,BLKSIZE=133) 00000180
//MPS2.SYSIN DD
//
IEF236I ALLOC. FOR PECK1336 MPS2
IEF237I 235 ALLOCATED TO STPLIB
IEF237I 234 ALLOCATED TO SYMLCP
IEF237I 233 ALLOCATED TO SCRATCH1
IEF237I 234 ALLOCATED TO SCRATCH2
IEF237I 232 ALLOCATED TO PROFILE
IEF237I 233 ALLOCATED TO MATRIX1
IEF237I 234 ALLOCATED TO ETA1
IEF237I 232 ALLOCATED TO MPSCRAT
IEF237I 233 ALLOCATED TO SYSPRINT
IEF237I 234 ALLOCATED TO SYSIN

```



MPS-PTF4

EXECUTOR.

MPS/360 V2-M10

NAME  
ROWS

SUBS

N VALUE

L SUB1

L SUB2

L SUB3

L SUB4

L SUB5

L SUB6

L SUB7

L SUB8

L SUB9

L SUB10

L SUB11

L SUB12

L SUB13

L SUB14

L SUB15

MIS1

MIS2

MIS3

MIS4

MIS5

MIS6

MIS7

MIS8

MIS9

MIS10

COLUMNS

X11 SUB1 1.00000

X12 VALUE 25.00000 SUB1 1.00000

X12 MIS2 .03000

X13 VALUE 25.00000 SUB1 1.00000

X13 MIS3 .02000

X14 SUB1 1.00000

X15 SUB1 1.00000

X16 SUB1 1.00000

X17 SUB1 1.00000

X18 SUB1 1.00000

X19 SUB1 1.00000

X110 VALUE 25.00000 SUB1 1.00000

X110 MIS10 .03000

X21 SUB2 1.00000

X22 VALUE 24.00000 SUB2 1.00000

X22 MIS2 .04000

X23 SUB2 1.00000

X24 SUB2 1.00000

X25 SUB2 1.00000

X26 SUB2 1.00000

X27 SUB2 1.00000

X28 VALUE 24.00000 SUB2 1.00000

X28 MIS8 .03000

X29 SUB2 1.00000

X210 VALUE 24.00000 SUB2 1.00000



J-PTF4		EXECUTOR.	MPS/360 V2-M10	
X210	MIS10	.04000		
X31	SUB3	1.00000		
X32	VALUE	23.00000	SUB3	1.00000
X32	MIS2	.05000		
X33	SUB3	1.00000		
X34	SUB3	1.00000		
X35	SUB3	1.00000		
X36	SUB3	1.00000		
X37	SUB3	1.00000		
X38	VALUE	23.00000	SUB3	1.00000
X38	MIS8	.04000		
X39	SUB3	1.00000		
X310	VALUE	23.00000	SUB3	1.00000
X310	MIS10	.05000		
X41	SUB4	1.00000		
X42	VALUE	23.00000	SUB4	1.00000
X42	MIS2	.06000		
X43	SUB4	1.00000		
X44	SUB4	1.00000		
X45	SUB4	1.00000		
X46	SUB4	1.00000		
X47	SUB4	1.00000		
X48	VALUE	23.00000	SUB4	1.00000
X48	MIS8	.05000		
X49	SUB4	1.00000		
X410	VALUE	23.00000	SUB4	1.00000
X410	MIS10	.05000		
X51	VALUE	20.00000	SUB5	1.00000
X51	MIS1	.05000		
X52	VALUE	20.00000	SUB5	1.00000
X52	MIS2	.08000		
X53	VALUE	20.00000	SUB5	1.00000
X53	MIS3	.06000		
X54	SUB5	1.00000		
X55	SUB5	1.00000		
X56	SUB5	1.00000		
X57	SUB5	1.00000		
X58	SUB5	1.00000		
X59	SUB5	1.00000		
X510	SUB5	1.00000		
X61	VALUE	20.00000	SUB6	1.00000
X61	MIS1	.04000		
X62	VALUE	20.00000	SUB6	1.00000
X62	MIS2	.06000		
X63	VALUE	20.00000	SUB6	1.00000
X63	MIS3	.05000		
X64	SUB6	1.00000		
X65	SUB6	1.00000		
X66	SUB6	1.00000		
X67	SUB6	1.00000		
X68	SUB6	1.00000		
X69	SUB6	1.00000		
X610	SUB6	1.00000		
X71	SUB7	1.00000		





-PTF4	EXECUTOR.	MPS/360 V2-M10		
X72	SUB7	1.00000		
X73	SUB7	1.00000		
X74	VALUE	17.00000	SUB7	1.00000
X74	MIS4	.10000		
X75	VALUE	17.00000	SUB7	1.00000
X75	MIS5	.10000		
X76	SUB7	1.00000		
X77	SUB7	1.00000		
X78	VALUE	17.00000	SUB7	1.00000
X78	MIS8	.10000		
X79	SUB7	1.00000		
X710	VALUE	17.00000	SUB7	1.00000
X710	MIS10	.11000		
X81	SUB8	1.00000		
X82	SUB8	1.00000		
X83	SUB8	1.00000		
X84	VALUE	17.00000	SUB8	1.00000
X84	MIS4	.12000		
X85	VALUE	17.00000	SUB8	1.00000
X85	MIS5	.10000		
X86	SUB8	1.00000		
X87	SUB8	1.00000		
X88	VALUE	17.00000	SUB8	1.00000
X88	MIS8	.12000		
X89	SUB8	1.00000		
X810	VALUE	17.00000	SUB8	1.00000
X810	MIS10	.13000		
X91	SUB9	1.00000		
X92	SUB9	1.00000		
X93	SUB9	1.00000		
X94	SUB9	1.00000		
X95	SUB9	1.00000		
X96	VALUE	17.00000	SUB9	1.00000
X96	MIS6	.01000		
X97	VALUE	17.00000	SUB9	1.00000
X97	MIS7	.04000		
X98	VALUE	17.00000	SUB9	1.00000
X98	MIS8	.08000		
X99	SUB9	1.00000		
X910	VALUE	17.00000	SUB9	1.00000
X910	MIS10	.07000		
X101	SUB10	1.00000		
X102	SUB10	1.00000		
X103	VALUE	15.00000	SUB10	1.00000
X103	MIS3	.11000		
X104	SUB10	1.00000		
X105	VALUE	15.00000	SUB10	1.00000
X105	MIS5	.09000		
X106	SUB10	1.00000		
X107	SUB10	1.00000		
X108	VALUE	15.00000	SUB10	1.00000
X108	MIS8	.07000		
X109	VALUE	15.00000	SUB10	1.00000
X109	MIS9	.05000		



MPS-PTF4	EXECUTOR.	MPS/360 V2-M10		
X1010	VALUE	15.00000	SUB10	1.00000
X1010	MIS10	.00000		
X111	SUB11	1.00000		
X112	SUB11	1.00000		
X113	VALUE	13.00000	SUB11	1.00000
X113	MIS3	.10000		
X114	SUB11	1.00000		
X115	VALUE	13.00000	SUB11	1.00000
X115	MIS5	.08000		
X116	SUB11	1.00000		
X117	SUB11	1.00000		
X118	VALUE	13.00000	SUB11	1.00000
X118	MIS8	.07000		
X119	VALUE	13.00000	SUB11	1.00000
X119	MIS9	.07000		
X1110	VALUE	13.00000	SUB11	1.00000
X1110	MIS10	.09000		
X121	SUB12	1.00000		
X122	SUB12	1.00000		
X123	SUB12	1.00000		
X124	VALUE	9.00000	SUB12	1.00000
X124	MIS4	.12000		
X125	SUB12	1.00000		
X126	SUB12	1.00000		
X127	VALUE	9.00000	SUB12	1.00000
X127	MIS7	.03000		
X128	VALUE	9.00000	SUB12	1.00000
X128	MIS8	.06000		
X129	SUB12	1.00000		
X1210	SUB12	1.00000		
X131	SUB13	1.00000		
X132	SUB13	1.00000		
X133	SUB13	1.00000		
X134	SUB13	1.00000		
X135	SUB13	1.00000		
X136	SUB13	1.00000		
X137	VALUE	7.00000	SUB13	1.00000
X137	MIS7	.03000		
X138	SUB13	1.00000		
X139	SUB13	1.00000		
X1310	SUB13	1.00000		
X141	SUB14	1.00000		
X142	SUB14	1.00000		
X143	SUB14	1.00000		
X144	SUB14	1.00000		
X145	SUB14	1.00000		
X146	VALUE	5.00000	SUB14	1.00000
X146	MIS6	.08000		
X147	VALUE	5.00000	SUB14	1.00000
X147	MIS7	.06000		
X148	VALUE	5.00000	SUB14	1.00000
X148	MIS8	.08000		
X149	VALUE	5.00000	SUB14	1.00000
X149	MIS9	.08000		



MPS-PTF4	EXECUTOR.	MPS/360 V2-M10		
X1410	VALUE	5.00000	SUB14	1.00000
X1410	MIS10	.06000		
X151	SUB15	1.00000		
X152	SUB15	1.00000		
X153	SUB15	1.00000		
X154	SUB15	1.00000		
X155	SUB15	1.00000		
X156	VALUE	1.00000	SUB15	1.00000
X156	MIS6	.09000		
X157	VALUE	1.00000	SUB15	1.00000
X157	MIS7	.67000		
X158	SUB15	1.00000		
X159	SUB15	1.00000		
X1510	SUB15	1.00000		
RHS				
ALOT1	SUB1	3.00000	SUB2	4.00000
ALOT1	SUB3	22.00000	SUB4	12.00000
ALOT1	SUB5	8.00000	SUB6	40.00000
ALOT1	SUB7	4.00000	SUB8	12.00000
ALOT1	SUB9	16.00000	SUB10	12.00000
ALOT1	SUB11	12.00000	SUB12	20.00000
ALOT1	SUB13	16.00000	SUB14	8.00000
ALOT1	SUB15	32.00000	MIS1	1.00000
ALOT1	MIS2	1.00000	MIS3	1.00000
ALOT1	MIS4	1.00000	MIS5	1.00000
ALOT1	MIS6	1.00000	MIS7	1.00000
ALOT1	MIS8	1.00000	MIS9	1.00000
ALOT1	MIS10	1.00000		
ENDATA				



## LIST OF REFERENCES

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This thesis relates the fact that, in the past, our ASW community has placed great (and justifiable) emphasis in detection and classification of submarines, while a serious lag in tactical procedures has developed. In order to alleviate this problem, it was felt that a systematic approach be taken which utilizes the principles of Operations Research.  By examining submarine warfare from the viewpoint of the Soviet Union, a resource allocation problem has been devised which compares the various		



submarine classes and the possible mission areas in which they may be assigned. Characteristics and available numbers of submarines were estimated, and the resulting allocation of forces was determined.

Although the analysis presented was based on hypothesized data, the strength in this approach lies in its flexibility and a wide range of applications. These features have been presented in Section III.



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toward developing ASW  
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